

Informative Data Set

more information in

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Intense industry competition has increased the pressure on managers to improve plant profitability; it is clear that business practices must change. Machinery specialists are no longer available at every plant. Maintenance and instrumentation staffs are being decreased and operators are being asked to do more with less training. With the magnitude and implication of these changes, it is time to reevaluate how rotating machines are protected and managed.

For many years, permanent vibration monitoring has helped plant managers protect machinery from damage. Most of these protection systems are rather simple, because they are based on overall vibration amplitude only. In these systems, action is usually initiated when overall vibration reaches one of two predefined levels. At a level predefined as the Alert limit, the operator is notified and a machinery specialist called in to determine the machine's health. When the predefined Danger limit is exceeded, the machinery is automatically shut down.

The vibration signal from a proximity probe contains much more information than just overall vibration. It is a complex waveform, rich with information. An entire industry is now devoted to analyzing this information and identifying the relationship between machine operation and vibration characteristics. These relationships have long been understood by machinery specialists, who use complex vibration information to identify

machine problems before they become destructive. This information gives managers time to plan repairs and modify plant operation, so machine run time is extended.

The Informative Data Set

Operators can take on a larger role in managing machines if they have better information in an easy-to-understand form. To accomplish this, Bently Nevada has introduced the Informative Data Set as standard in all 3500 System Vibration Monitors, Bently Nevada's newest and most advanced vibration monitoring system. The Informative Data Set is not all of the information available from a proximity probe; it is just the essential data required for machinery management. It consists of overall vibration amplitude, probe gap voltage, 1X vibration amplitude and phase, 2X vibration amplitude and phase, and Not 1X vibration amplitude.

Overall Amplitude

The overall amplitude of a vibration signal can be composed of many components. Usually, it is used to indicate the vibration level at which machine damage will occur: the Danger point. This has been the primary mode of machine protection. The specialist knows, however, that there are many malfunctions that are not indicated by an increase in overall vibration. Many faults can even decrease overall vibration.

1X amplitude and phase

1X vibration is vibration that is synchronous with shaft rotational speed. Because it is vibration filtered to running speed, it is a vector with both amplitude and phase information. Many machinery

vibration problems, possibly as much as 50 percent, cause a change in 1X vibration. It is possible to have a significant change in the 1X vector with little or no change in overall amplitude. More than forty faults that cause changes in 1X vibration have been identified. However, most changes in 1X amplitude and phase are due to changes in the balance state of the rotor. Gradual changes in 1X vibration should be analyzed, but generally do not require an immediate change in machine operation or an urgent call for a specialist.

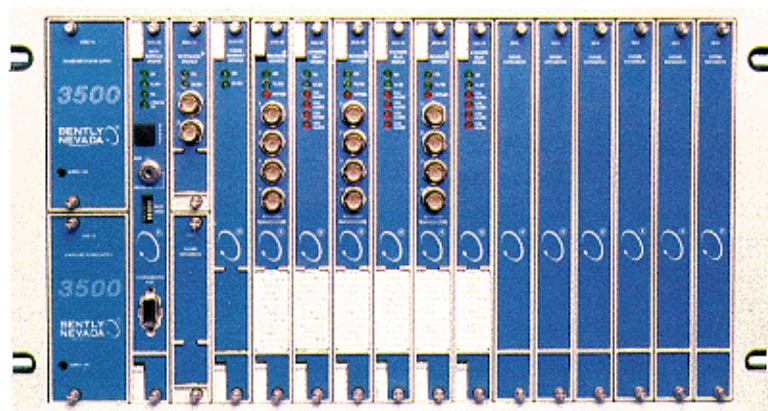
2X amplitude and phase

2X vibration is vibration that is synchronous with twice the shaft rotational speed, and it is also a vector with both amplitude and phase information. Changes in 2X amplitude and phase can indicate radial loads or rotor asymmetry. Shaft crack diagnosis includes study of the machine's 2X vibration history. Gradual changes are important, but alone are seldom cause for emergency action. They may precede faster changes, so identifying such a change can help avoid a later emergency. Large, instantaneous changes in the 2X vector indicate a more severe machine problem, and require immediate attention.

Not 1X vibration amplitude

Not 1X vibration is all vibration that is not synchronous with running speed, and it contains no phase information. Not 1X vibration often indicates malfunctions that can quickly damage a machine. Some of the most common causes of Not 1X vibration are fluid-induced instabilities, rotor-to-stator rubs and gear faults. All are of immediate concern. Not 1X vibration may also indicate

a more meaningful format



operation or process problems, such as compressor surge and pump cavitation.

How severe is the problem? How much time do I have?

With the Informative Data Set, an operator now has more information available when a vibration alarm occurs. Any alarm indicates change, and any change warrants an investigation into its root cause. It is always appropriate to evaluate overall vibration amplitude and the overall vibration trend file. Instantaneous changes are more significant than gradual changes. Higher amplitudes, in general, require more immediate response than lower ones.

After looking at the overall vibration amplitude, the operator should examine Not 1X vibration amplitude. If Not 1X vibration has increased or changed significantly, a specialist should be consulted to determine the root cause. Changes in the 1X amplitude are usually associated with changes in balance, with no increase in Not 1X or the 2X components. This could be normal for the operation, depending upon the machine or the service. Regardless, as long as the lev-

els remain stable at the new levels, emergency action isn't warranted.

Changes in the 1X or 2X vectors can occur without an increase in overall amplitude. Gradual changes might indicate a shaft crack, and, therefore, should be investigated as soon as possible, but are not usually an emergency. Sudden changes in 1X or 2X vectors may be an indication of more serious problems and should be investigated immediately.

The 3500 Machinery Management System

The 3500 Machinery Management System is our newest and most advanced vibration monitoring system. Its advancements make it less expensive to install and use, and make the comprehensive information it acquires readily available. Its advantages are:

- Reduced installation and maintenance costs
- Improved availability
- Improved integration
- Enhanced operational information
- Advanced Diagnostics
- Proactive machinery management

Reduced installation and maintenance costs

The 3500 can use a single, multiconductor cable to carry signals from transducer termination blocks to the 3500, which reduces cabling costs. The 3500 can be mounted on machine skids, which shortens cable runs. It is compatible with our transducer and diagnostic systems, so you can connect it to your existing Bently Nevada equipment.

Maintenance is less expensive. The 3500 System is configured through graphical software that is intuitive and easy-to-use. With its optional, internal modem, you can configure the 3500 from a remote location. Fewer spares are required, because certain 3500 Monitors can be programmed to perform several different functions. Such a monitor can serve as a spare for several different monitor types.

Improved availability

The 3500 System helps meet the special vibration monitoring requirements of Emergency Shutdown Systems (ESD) applications. This new system also provides high quality machine protection and the additional features required for safety-critical applications. Both standard and safety critical 3500 racks share communication protocol and most hardware, reducing the amount of spare parts required and simplifying personnel training.

Triple Modular Redundant applications require a redundant power supply. This option is available with the 3500 System. The 3500 System also retains its configuration information, even if the rack loses power.

Improved integration

The 3500 communicates with plant computers and Distributed Control Systems (DCS) through its Communication Gateway. A single 3500 rack can communicate with several different systems, simultaneously. For instance, one 3500 rack can simultaneously provide data via different protocols, to a DCS and to a low-cost remote display. You can synchronize the 3500's clock with that on the system that monitors your plant processes, giving you the power to correlate process changes with machine vibration.

Enhanced operational information

You can view 3500 data anywhere in your plant, by connecting a single cable from the 3500 Monitoring System to any Modbus Remote Panel. You can view 3500 data from anywhere in the world, by using its optional, internal modem.

The 3500 Operator Display Software runs under Microsoft Windows for Workgroups, and it can supply data to another Windows for Workgroups computer through the Dynamic Data Exchange (DDE). It also supports the Transmission Control Protocol and Internet Protocol (TCP/IP), the File Transfer Protocol (FTP) and the X Window Protocol.

Advanced diagnostics

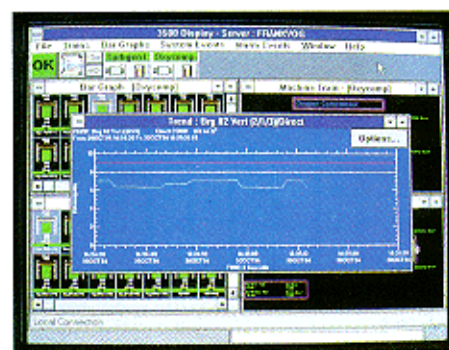
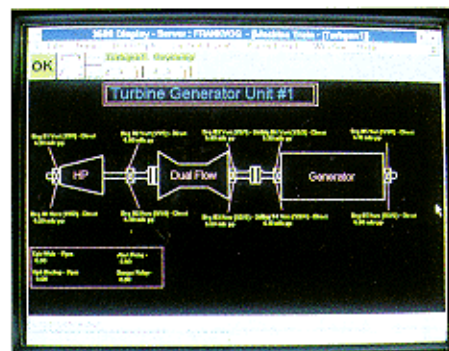
The 3500 Machinery Management System provides the information that is essential for a machinery management program. The 3500 and the 3500 Operator Display Software communicate via several protocols, so it integrates in many common plant information systems. It works well with Bently Nevada's online diagnostic systems, as part of a comprehensive approach to increasing plant profitability.

Proactive machinery management

As machinery experts become increasingly scarce, machine operators must make more decisions. When a machine's vibration increases to a level that triggers an alarm, the operator must decide whether to shut the machine down immediately, wait until an expert arrives, or modify plant operation to reduce machine vibration. This is the essence of machinery management. A correct decision requires more than just overall vibration information.

Often, a plant's overall profitability is maximum when the process runs at less than full capacity, because machine downtime is minimized. Better information helps operators to modify the process so machine life is extended. First, a machinery specialist uses comprehensive vibration information to identify process-related machine problems. Then, he teaches operators to associate certain vibration characteristics with certain process conditions. Later, when a vibration alarm occurs, operators can quickly determine if it is associated with a process condition, and if so, can take appropriate action.

However, machinery specialists are also in greater demand. With fewer experts available, those who remain must manage more machines in more plants. Better information, and the trend data available from Bently Nevada diagnostic systems and most DCS and plant information systems, increases a machinery specialist's productivity. His productivity increases much more if he uses modern diagnostic tools. These tools enable him to analyze problems without travelling to the machine site, by transmitting data via networks and modems. Bently Nevada offers a broad range of products designed to increase a machinery specialist's productivity.



- The world's best portable diagnostic system: ADRE® for Windows.
- Online machinery management system: Transient Data Manager ®2
- Our online expert system: Engineer Assist™.

Have we seen it before?

What can we do?

Often, a machine malfunction has been diagnosed by an expert, who has determined that the machine can still run safely until a scheduled outage. When this happens, process capacity must often be reduced to accommodate the poor health of the machine. The Informative Data Set helps determine the optimum operating level. Operating the process with this information can vastly improve plant profitability.

A large steam turbine generator makes a good example. Often, light loading or excessive bearing clearance on the first bearing of the HP turbine will allow a fluid-induced instability to occur. This is usually highly dependent on load. An operator monitoring Not 1X vibration can determine if an instability is present and can adjust the load to minimize it. Normally, steam turbine vibration signals are predominantly 1X vibration; therefore, the presence of Not 1X is a very significant indication of a problem. However, without Not 1X vibration information, the load would most certainly be decreased until the problem was identified. The uncertainty would cause unnecessary concern, and most likely, loss of profitability.

Summary

In the past, simple, overall vibration data that protected machines from damage was adequate to maintain plant profit. No more; today's more competitive business environment requires more sophisticated information to support a more sophisticated machinery management methodology. The minimum information required is the Informative Data Set. The best system for making this data available is Bently Nevada's new 3500 Machinery Management System. Contact your nearest Sales and Service representative for more information. ■